WATER CONSULTING, INC.
EMAIL: WCI@WATERCONSULTING.COM • WEB: WWW.WATERCONSULTING.COM

CORPORATE HEADQUARTERS
120 SOUTH FIFTH STREET, SUITE 201, P.O. BOX 981
HAMILTON, MONTANA 59840
FACSIMILE: (406) 363-5322
OFFICE: (406) 363-2828

WHITEFISH OFFICE
576 SPOKANE AVENUE
WHITEFISH, MONTANA 59937
FACSIMILE: (406) 862-2182
OFFICE: (406) 862-2234

August 8, 2002

Mr. Melvin and Lerah Parker
P.O. Box 609
Libby, Montana 59923

RE: Comments on Rainy Creek / Kootenai River Bank Restoration Project Design

Dear Mr. Parker:

Water Consulting, Inc. (WCI) is in receipt of the U.S. Department of Transportation's (USDOT) preliminary design plan for the Rainy Creek / Kootenai River Bank Restoration project near Libby, Montana. Per your request, WCI has reviewed the plan set and offers the following comments on the technical components of the project design.

Reference Reach Analysis

In a memorandum dated May 7, 2002 to Peter Borowiec, PE from Bob Rennick and Darrel Stordahl, PE, it was indicated "CDM conducted a reference reach study of approximately 220 feet of Rainy Creek located immediately above the Screening Plant property." Additionally, it was noted, "The reference reach will be characterized based on the Rosgen classification system (Rosgen, 1996)." WCI assumes that CDM completed a Level III stream channel stability and characterization analysis for both the reference reach and project area to evaluate degree of geomorphic departure, potential, and to assist with development of the design plan geometry. Attached to this letter is a standard form used to complete the Rosgen analysis referenced by CDM. This attachment is one component of the Rosgen methodology for designing impaired stream reaches and is endorsed as a mandatory requirement by the U.S. Fish and Wildlife Service on all proposed stream mitigation projects. Since CDM indicated they conducted a Rosgen classification and characterization, we assume this information is readily available as it is the primary component of the Rosgen analysis. As such, we are requesting the information contained in the attachment to this letter be completed by CDM and made available for review by WCI (see attachment, Morphological

Characteristics of the Existing and Proposed Channel with Gage Station and Reference Reach Data, Rosgen, 1996).

Channel Encroachment

The proposed channel design indicates additional placement of 1.79 – 2.0 ft. diameter riprap along the existing channel margins of Rainy Creek and MDT Class II riprap from the new bankfull channel edge to the top of the existing rip-rap. The design bankfull width on the riffle sections will measure 10.0-ft. with a mean depth of 2.0 ft., resulting in a channel width/depth ratio of 5 (reference Sheet No. 9 of Plan Set). Reference reach information collected by WCI on a stable reference reach of Rainy Creek indicates an average width/depth ratio of 7.8. Does the reference reach data support a width/depth ratio of 5? With placement of additional riprap above bankfull elevation, what will the resulting entrenchment ratio measure? What type of channel is proposed by CDM in the project area? Additionally, based on review of existing channel conditions, a significant length of the project channel displays widths less than 10.0-ft. To achieve the design channel dimensions of 10.0 ft. (width), the contractor will have to excavate portions of the existing channel to expand the bankfull width. The design plans do not indicate ✓ where expansion of the bankfull channel is proposed in order to meet the minimum width of 10 ft.

Assuming an average bankfull channel depth of 2.0 ft., average energy grade line (i.e. water surface slope) of .073 ft/ft., the resulting shear stress generated in the channel during bankfull flow conditions will exceed 9.0 lbs/ft^2. The existing channel material is ✓ not competent to withstand these boundary conditions. WCI recommends expanding the active channel width to increase the bankfull channel width/depth ratio. It is already apparent that the existing channel is not competent to maintain vertical stability as evidenced by isolated vertical incision of the channel this past spring. Increasing the width/depth ratio will reduce boundary shear stress and make the channel bottom perimeter sediments much less susceptible to scour and mobilization. As noted in WCI's Hydrologic Review of Rainy Creek Restoration Project (February 27, 2002), it was noted that the existing cross-section dimensions of the project area deviate from the reference dimensions. In particular, the constructed bankfull cross-sectional area is approximately 43% less than the reference reach. This apparently resulted from encroachment on the channel from riprap revetment. WCI fails to see how placement of additional rock encroachment within the active channel will increase cross-sectional geometry to the appropriate dimensions. Additionally, following field review this spring, it is apparent that shifting and failure of existing rock riprap that was insufficiently keyed has resulted in further displacement of cross-sectional area. Rather than place additional rip-rap ✓ within the active channel, WCI recommends expanding the existing channel dimensions, where necessary, to facilitate establishment of the proper channel width/depth ratios, cross-sectional area, and entrenchment ratio. Placement of additional riprap is completely unwarranted for this geomorphic setting.

✓ WCI would request a more detailed evaluation of the effects of additional riprap placement (above bankfull stage) on flood flow conveyance. This was not adequately addressed in the design.

Channel Hydraulics

✓ To validate the proposed channel design dimensions proposed by CDM, WCI would recommend a HEC-RAS model be completed for the project reach to evaluate bankfull hydraulics, boundary conditions, conveyance, and predicted low flow, bankfull, and flood flow water surface elevations. The use of FlowMaster, as noted in the CDM report, is not appropriate software for calibrating channel hydraulics in a dynamic open channel system such as Rainy Creek. The equations used in FlowMaster deal mainly with uniform flow. Uniform flow refers to hydraulic conditions in which the flow depth, channel discharge, and flow area do not change over a channel reach with constant section characteristics such as shape and material. These conditions are only met when the channel bottom slope and the friction slope are equal. Since Rainy Creek will have an undulating bedform profile between pool and riffle sections, the channel characteristics will vary significantly and uniform flow criteria will certainly not be characteristic at any flow stage. As such, use of FlowMaster to calibrate the design channel geometry and open channel hydraulics is inappropriate.

✓ **J-Vane Structures**

The proposed "j vane structures" are straight rock vanes, versus j-vanes that are composed of a curved rock throat resembling a 'j' (see Photo 1). The placement of vane structures on the plan view design should be modified to maximize their effectiveness in reducing near-bank stress. Given the armored nature of the existing and proposed streambanks, bank erosion is unlikely in this setting. Rather than install straight "j-vanes" as indicated in the CDM report, WCI would recommend use of j-hook vanes. These types of vanes are more effective at promoting pool formation in the near-bank region and dissipating instream energy. Vanes are typically placed at the upstream inflection point of the meanders and spaced according to radius of curvature and channel slope to maximize their effectiveness as both an energy dissipation and habitat forming structure. In lieu of more detailed design information, the following location changes are recommended:

Existing Station	Proposed Station and Bank Tie Point
2+56	2+70, Left Channel Edge viewing downstream
4+61	4+85, Right Channel Edge viewing downstream
5+05 (approx)	5+15, Left Channel Edge viewing downstream
5+68	5+35

WCI also requests the dimensions of the j-vane structures, in particular:

1. The length and slope of the vane arms, and
2. The predicted maximum scour depth and footing depth of all structures.

The following photo demonstrates the use of j-hook vanes on a larger stream system in Colorado.

Photo 1. Typical j-hook vane structure. Note effectiveness at reducing near bank stress and forming pool habitat.

Pool Geometry and Design

Pools have been incorporated in the design to provide for energy dissipation and fish habitat. However, the spacing, as displayed on the design plan sheets, is not consistent with the spacing measured from the upstream reference reach. As noted in WCI's Hydrologic Review of Rainy Creek Restoration Project (February 27, 2002), steps and pools, with an average spacing of 12-ft, dominated the bedform profile. The ratio of steps to bankfull channel width ranged from 1.0 – 1.3, which is typical for these stream types and gradients. The design proposed by CDM and USDOT indicate an average pool spacing of 100 – 200 ft (range). This spacing deviates significantly from those measured on the upstream reference reach. WCI would recommend a minimum step-pool spacing of 12 – 15 ft. to provide for adequate energy dissipation in the project reach.

The use of grout is not necessary in these types of stream environments. WCI has completed over 200 stream restoration projects over the past seven years on stream ranging in size from 2-ft. to over 200 ft in width. WCI has yet to utilize grout as a scour protection measure or to facilitate sealing of the channel materials on any of these projects. This non-native material will effectively reduce intergravel flow in the pool environments, which in turn, will inhibit potential spawning, gravel retention in pool tailouts, and reduce the quality of the pool habitat for fish utilization.

In terms of the pool geometry, what is the maximum predicted head differential on the individual pool structures during low flow and bankfull flow conditions? What is the designed energy grade line of the pools relative to the average reach slope? These calculations should be incorporated in the design to address pool hydraulics and their effectiveness and function.

Culvert Installation

The design plans indicate installation of an additional 48-inch corrugated metal pipe. While this addition will increase the conveyance capacity of the crossing, it is highly likely that split flow conditions will create an even shallower flow depth during low flow periods, thereby accentuating the crossing as a fish passage barrier during certain periods. Has a fish crossing analysis been completed for the design for all affected species and age classes? Has the sediment transport function of the double culverts been assessed?

Thanks you for the opportunity to comment on the proposed mitigation plan for Rainy Creek. In conclusion, WCI does not advocate the types of methods being proposed for the site. In addition to using non-native materials such as excessive riprap and grout, it appears as though fundamental geomorphic evaluations have either been omitted from the design plans or altogether not considered. There are many softer type treatments available that would retain the natural appearance and function of Rainy Creek while meeting the project goals and objectives developed by USDOT. If USDOT would like to entertain use of these alternative methodologies, we would be more than willing to assist their staff with development of a geomorphically-based design plan.

Sincerely,

Water Consulting, Inc.

John M. Muhlfeld
Senior Hydrologist

Matt Daniels, P.E.
Hydraulic Engineer

cc: Mike Hensler, Montana Department of Fish, Wildlife & Parks
Vicki McGuire, Lincoln Conservation District
Doug McDonald, US Army Corps of Engineers

MORPHOLOGICAL CHARACTERISTICS OF THE EXISTING AND PROPOSED CHANNEL WITH GAGE STATION AND REFERENCE REACH DATA

(Rosgen, 1996)

Restoration Site (Name of stream & location):
USGS Station (No. & location):
Reference Reach (Name of stream & location):

	VARIABLES	EXISTING CHANNEL	PROPOSED REACH	USGS STATION	REFERENCE REACH
1.	Stream type				
2.	Drainage area (sq.mi.)				
3.	Bankfull width (W_{bkf})		Mean: Range:		Mean: Range:
4.	Bankfull mean (d_{bkf})		Mean: Range:		Mean: Range:
5.	Width/depth ratio (W_{bkf}/d_{bkf})		Mean: Range:		Mean: Range:
6.	Bankfull cross-sectional area (A_{bkf})		Mean: Range:		Mean: Range:
7.	Bankfull mean velocity (V_{bkf})				
8.	Bankfull discharge, cfs (Q_{bkf})				
9.	Bankfull Maximum depth (d_{max})		Mean: Range:		Mean: Range:
10.	Max d_{riff}/d_{bkf} ratio		Mean: Range:		Mean: Range:
11.	Low bank height to max. d_{bkf} ratio		Mean: Range:		Mean: Range:
12.	Width of flood prone area (W_{fpa})		Mean: Range:		Mean: Range:
13.	Entrenchment ratio (W_{fpa}/W_{bkf})		Mean: Range:		Mean: Range:
14.	Meander length (L_m)		Mean: Range:		Mean: Range:
15.	Ratio of meander length to bankfull width (L_m/W_{bkf})		Mean: Range:		Mean: Range:

16.	Radius of curvature (R_c)		Mean: Range:		Mean: Range:
17.	Ratio of radius of curvature to bankfull width (R_c/w_{bkf})		Mean: Range:		Mean: Range:
18.	Belt width (w_{blt})		Mean: Range:		Mean: Range:
19.	Meander width ratio (w_{blt}/w_{bkf})		Mean: Range:		Mean: Range:
20.	Sinuosity (stream lenth/valley distance) (k)				
21.	Valley slope (ft/ft)				
22.	Average slope (s_{avg}) = (s_{valley}/k)				
23.	Pool slope (s_{pool})		Mean: Range:		Mean: Range:
24.	Ratio of pool slope to average slope (s_{pool}/s_{bkf})		Mean: Range:		Mean: Range:
25.	Maximum pool depth (d_{pool})		Mean: Range:		Mean: Range:
26.	Ratio of pool depth to average bankfull depth (d_{pool}/d_{bkf})		Mean: Range:		Mean: Range:
27.	Pool width (w_{pool})		Mean: Range:		Mean: Range:
28.	Ratio of pool width to bankfull width (w_{pool}/w_{bkf})		Mean: Range:		Mean: Range:
29.	Ratio of Pool Area to Bankfull Area		Mean: Range:		Mean: Range:
30.	Pool to pool spacing (p-p)		Mean: Range:		Mean: Range:
31.	Ratio of p-p spacing to bankfull width (p-p/w_{bkf})		Mean: Range:		Mean: Range:

MATERIALS:				
1. Particle Size Distribution of Channel Material				
D_{16}				
D_{35}				
D_{50}				
D_{84}				
D_{95}				
2. Particle Size Distribution of Bar Material				
D_{16}				
D_{35}				
D_{50}				
D_{84}				
D_{95}				
Largest size particle at the toe (lower third) of bar				

SEDIMENT TRANSPORT VALIDATION (BASED ON BANKFULL SHEAR STRESS)	
Calculated value (lb/ft^2)	
Value from Shields Diagram (mm)	
Critical dimensionless shear stress	
Minimum mean d_{bkf} calculated using critical dimensionless shear stress equations	

Remarks: ______________________________